Lewis Structures

Lewis structures are important because they allow one to determine the shape of a molecule as well as the availability (or not) of lone pair(s) of electrons, which are important in predicting chemical reactivity (especially basicity) of compounds. Lewis (electron dot) structures can be written quite simply if the following rules are followed.

1. Draw a skeleton structure incorporating all atoms in as symmetrical a structure as possible, using single bonds to connect atoms and obeying the usual valences of the elements: C = 4, N = 3, O = 2, S = 2, H = 1, X (halogen) = 1. Place hydrogens and halogens to the outside of the structure, and place oxygens closer to the atom at the center.

2. Total the number of valence electrons contributed by the atoms (# valence electrons = Group # from the Periodic table).

3. Adjust the total for any ionic charge (add for - , subtract for +).

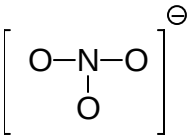
4. Subtract 1 pair of electrons per bond in skeleton structure.

5. Arrange remaining electrons around atoms as symmetrically as possible, giving each atom an octet (8 electrons) except H, which only requires 2.

6. If necessary, share a pair from an atom that has an octet with an adjoining atom that is deficient so as to create a double (or triple) bond.

Examples: NO_3^-

Step 1:



Step 2:

	N	5e
	O	6e
	O	6e
	O	6e
	sum:	23e

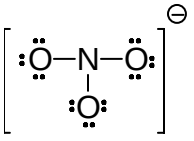
Step 3:

neg. charge:		+1e
	Total	24e

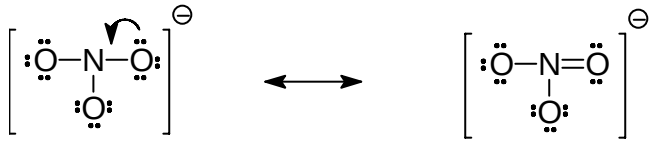
Step 4:

-6e (skeleton: 3 bonds x 2e per bond)
18e (distribute these as symmetrically as possible):

Step 5:



Step 6:

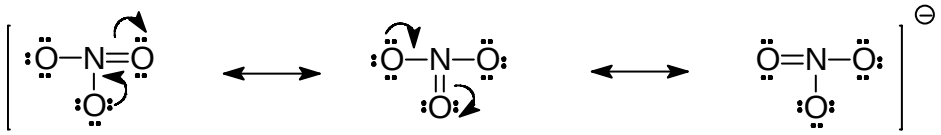


share as necessary (an acceptable Lewis structure)

Resonance:

When more than one acceptable Lewis structure can be written for a molecule or ion, the set of acceptable Lewis structures is referred to as resonance forms. A molecule or ion which has one or more resonance forms is generally lower in energy (= more stable) than otherwise predicted, and the actual structure is like a time average of the several contributing structures.

In the case of the nitrate ion just examined:



Valence Shell Electron Pair Repulsion (VSEPR) Rules for Predicting Molecular Geometry

# of Geom-determining electron pairs (= bonding pairs + non-bonding pairs, counting only one pair per bond)	**4** 109.5°, sp^3			**3** 120°, sp^2		**2** 180°, sp
# Pairs Non-Bonding	0	1	2	0	1	0
Geometry	tetrahedral	trigonal pyramid	V-shaped	trigonal planar	V-shaped	linear
Examples	CH_4	NH_3	H_2O	NO_3^-	NO_2^-	NO_2^+